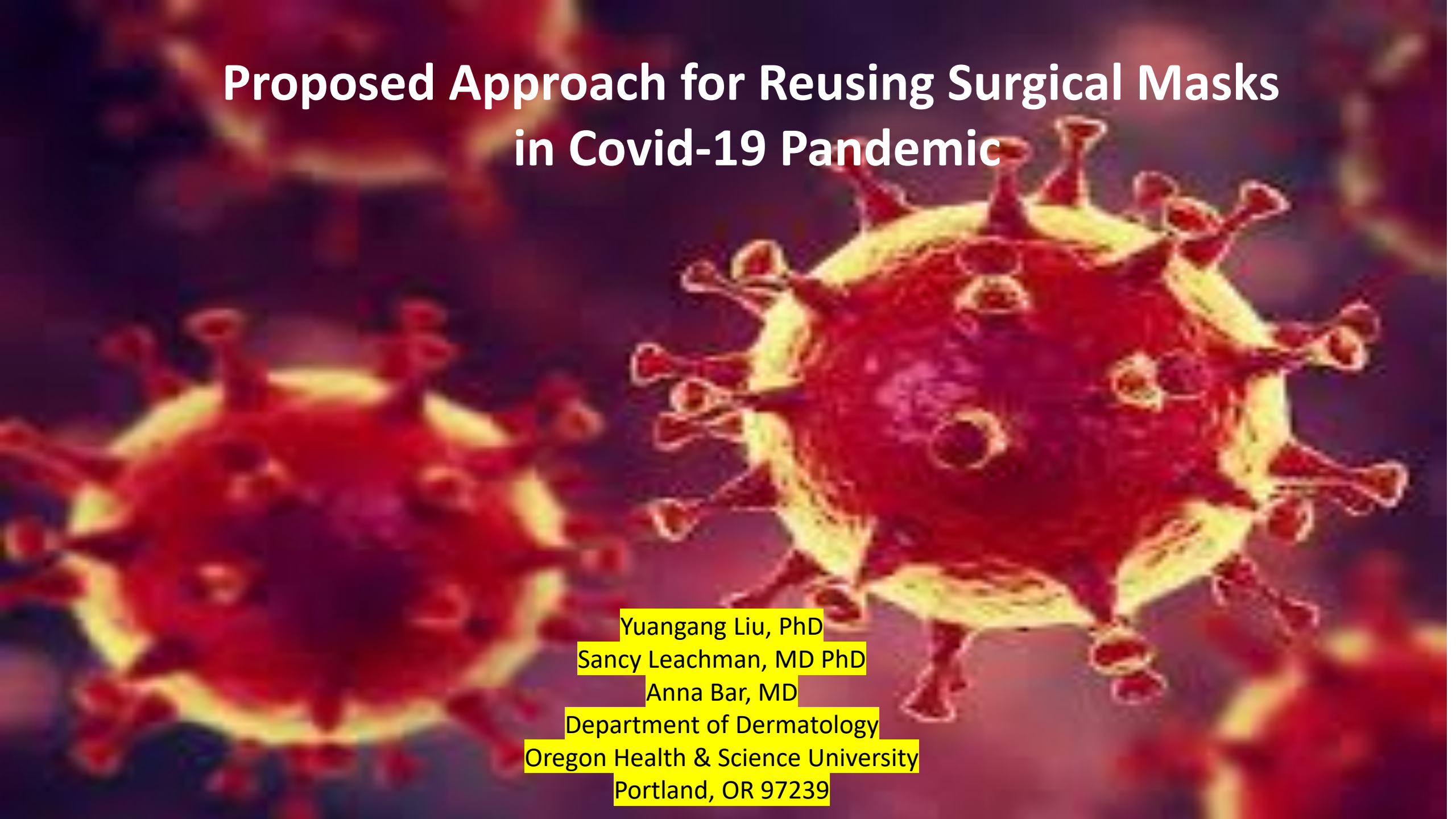
Proposed Approach for Reusing Surgical Masks in Covid-19 Pandemic



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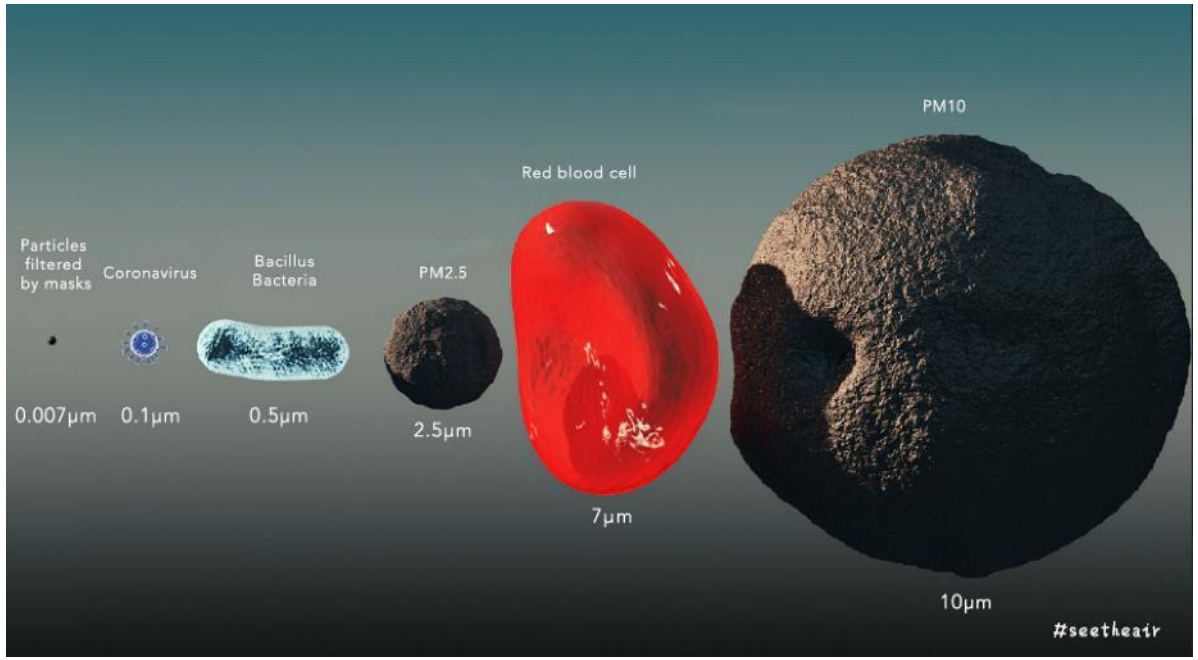
Face mask protection blocks and absorbs virus on the mask fiber filter

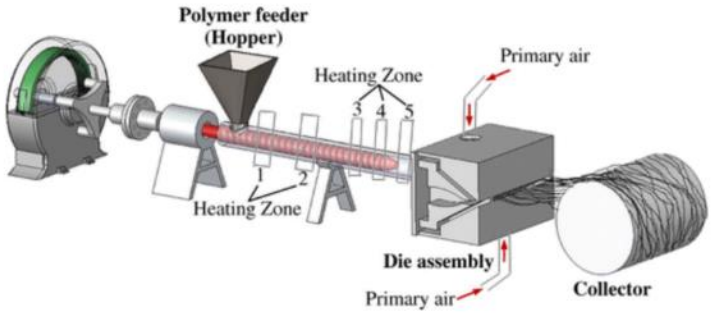
Coronavirus: 0.1µm



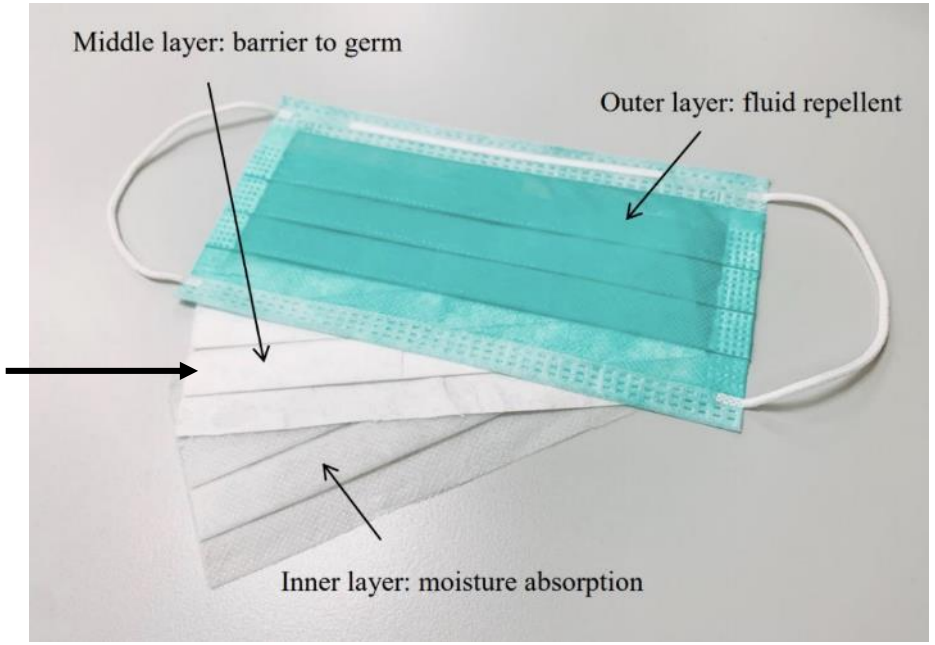
Pore size of N95: 0.1 -0.3 µm

Pore size of standard surgical mask: 0.3-10 µm

The filtration efficiency of mask is determined by the meltblown polypropylene fabric of the middle layer



Polypropylene —(215 C° - 260 C°)→ **meltblown polypropylene** →



Polypropylene filter should be stable at elevated temperatures

Rationale for Wearing a Face Mask

1. **Covid-19 is an airborne disease**
2. **The half life of viable SARS-CoV2 in aerosol is more than one hour**

   (Van Doremalen N, et al. NEJM, 2020)
3. **There is a large population of asymptomatic carriers (Li R, et al. Science, 2020)**
4. **Salivary viral load is highest during the first week after symptom onset**

   (To K. K-W, et al. The Lancet, 2020)
5. **Covid-19 infection trajectory has plateaued in areas where wearing a face mask is popular (South Korea, Japan and China)**
6. **If effective, may help to more rapidly alleviate the pressure of physical quarantine**

Additional Rationale for Wearing Surgical Masks At Work

1. Reduces viral spread from asymptomatic carriers
2. Reduces touching mouth and nose
3. Reduces respiratory system access
4. Reduces viral transmission from asymptomatic medical professionals to patients and colleagues

BMJ

RESEARCH

Physical interventions to interrupt or reduce the spread of respiratory viruses: systematic review

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ABSTRACT

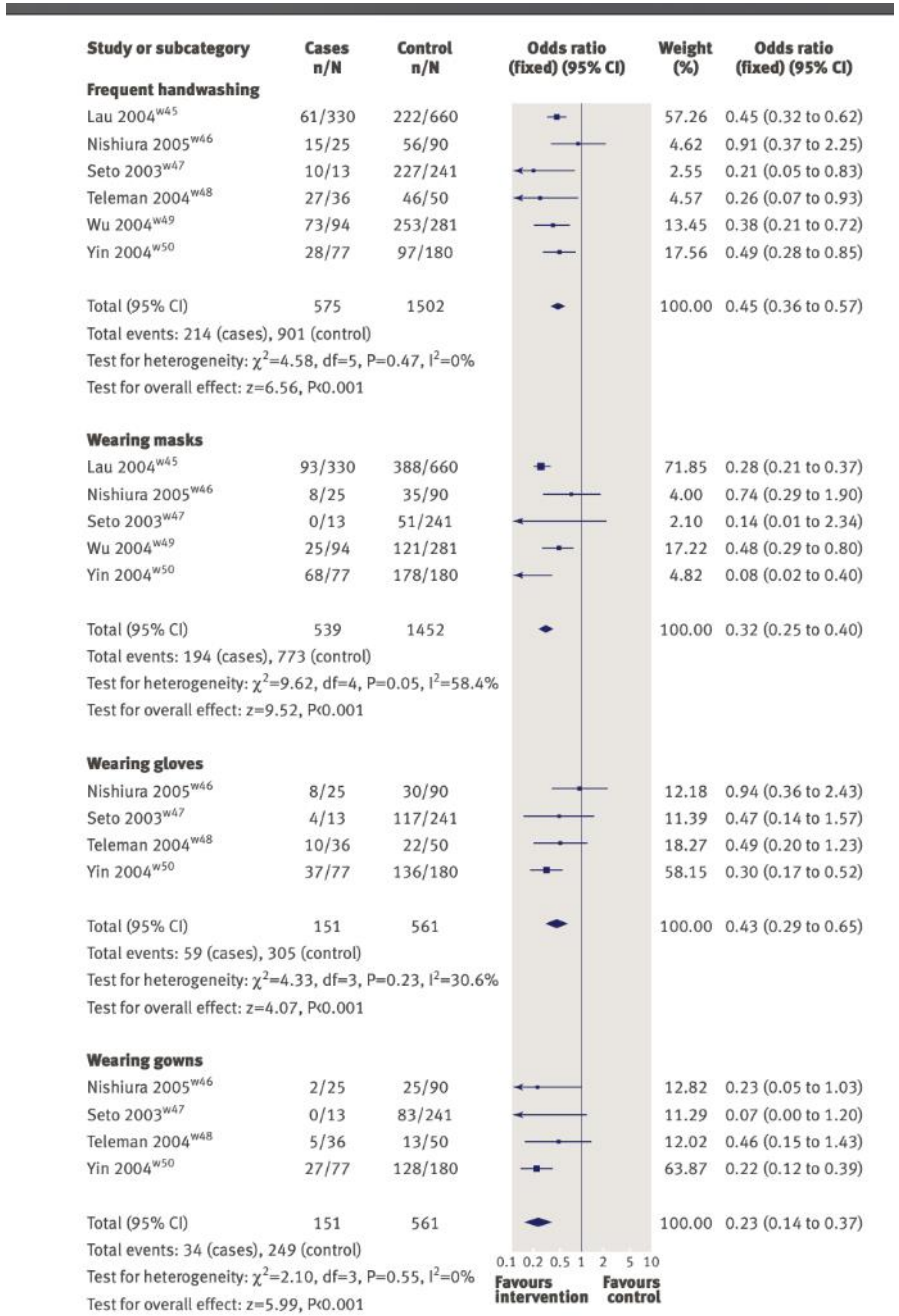
Objective To systematically review evidence for the

INTRODUCTION

Although respiratory viruses usually cause minor dis-

Frequent handwashing, wearing masks, wearing gloves, and wearing gowns all found to decrease the spread of respiratory viruses in meta-analysis

BMJ Oct 2007



Severe surgical mask shortage exists

1. **Surgical mask supply is largely dependent on import from China where business is dominated by politics**

2. **The outbreak of Covid-19 in China 2 months ago depleted global face mask stock**

3. **Limited production capacity in US (400 million N95 annually)**

300 million American need 109 billion face masks annually if one person use one face mask per day

Solutions for face mask shortage

1) Speed up face mask production
2) **Reusing face mask**
3) **Home made face mask for personal use**
    - **Using Halyard H600, a 2-ply spun polypropylene that is used to wrap surgical instruments for autoclaving**

Conditions to kill coronavirus

70% ethanol for 5 min

10% bleach for 5 min

H2O2 Vapor

Moisture compromises the filtration efficiency of the polypropylene filter and it is recommended that face masks contaminated with fluid should not be reused.

UVC

UVC does not penetrate to the depth of the filter and does not kill Coronavirus as well.

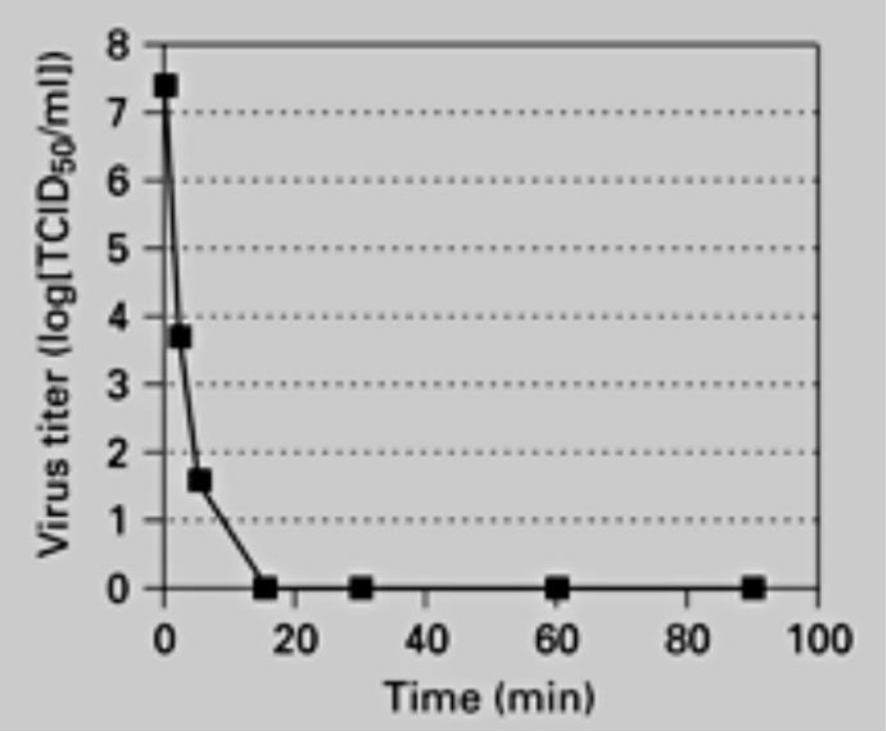
56C^{o} or above for 30 min

(WHO Recommendations)

https://www.who.int/csr/sars/survival_2003_05_04/en/

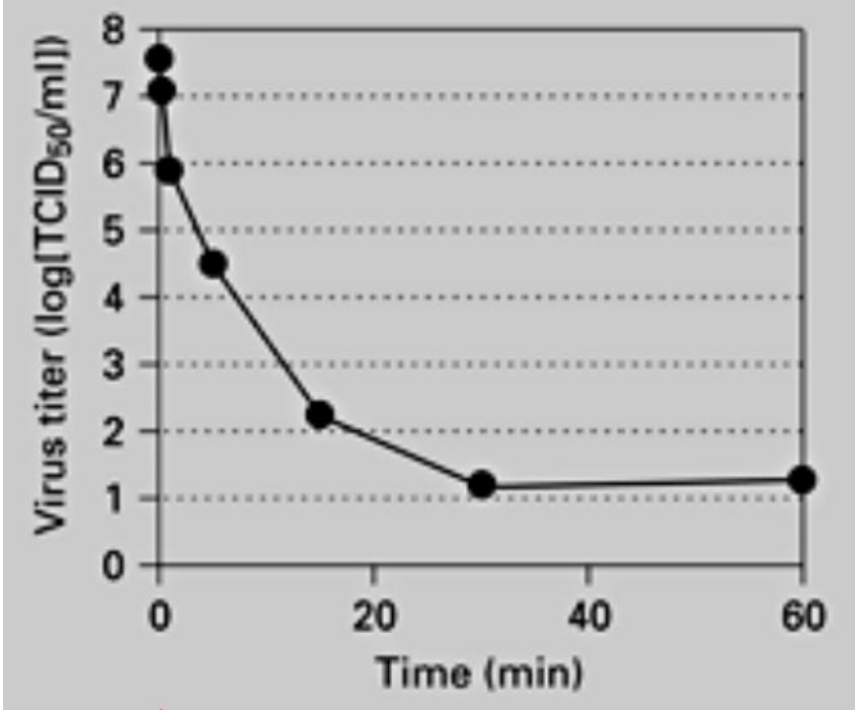
Coronavirus is eliminated by heating at 65 C° for 30 min

65 C°



Coronavirus cannot be eliminated by UV irradiation for 30 min

134 μW/cm2



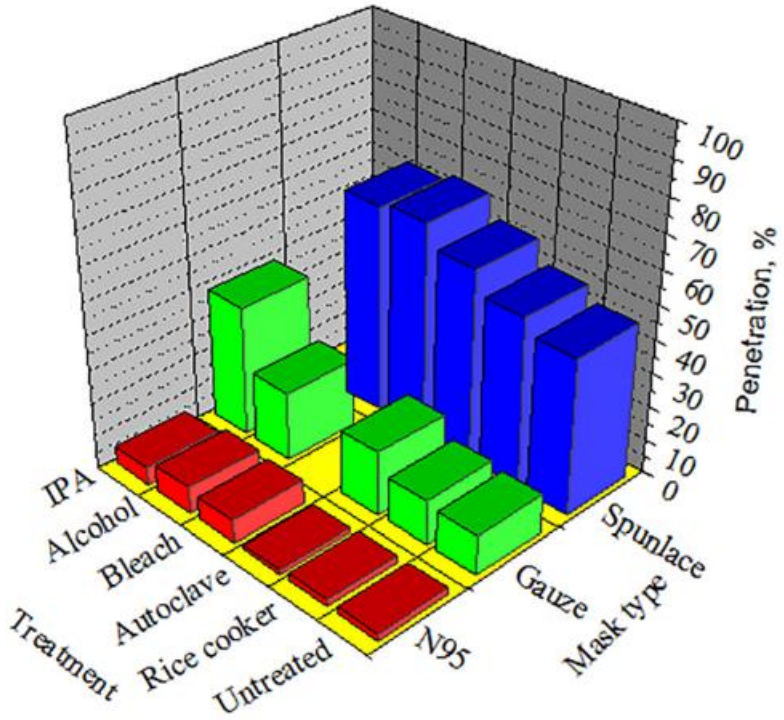
Hiroaki Kariwa, et al. Dermatology 2006;212(suppl 1):119–123

Dry heat is a preferred method for decontamination of face mask

Table 1. Decontamination methods.

Method	Experimental Conditions and Parameters
Rice cooker	Place the test masks in a traditional electric rice cooker using dry heat for 3 minutes (149~164˚C, without adding water).
Autoclave	Set the temperature at 121˚C with 1.06 kg cm^{-2} for 15 minutes.
Ethanol *	10 min submersion in 70% ethanol solution.
IPA *	10 min submersion in 100% isopropanol solution.
Bleach *	10 min submersion in 0.5% sodium hypochlorite solution (original concentration = 0.5% available as Cl_2). Manufacturing specification: 0.5% (w/w) available chlorine.

*Liquid submersion methods. Following each exposure, masks were placed in a laboratory chemical hood and allowed to air-dry overnight before performing the laboratory aerosol filtration test.



Lin T-H, et al. PLoS ONE 12(10): e0186217, 2017

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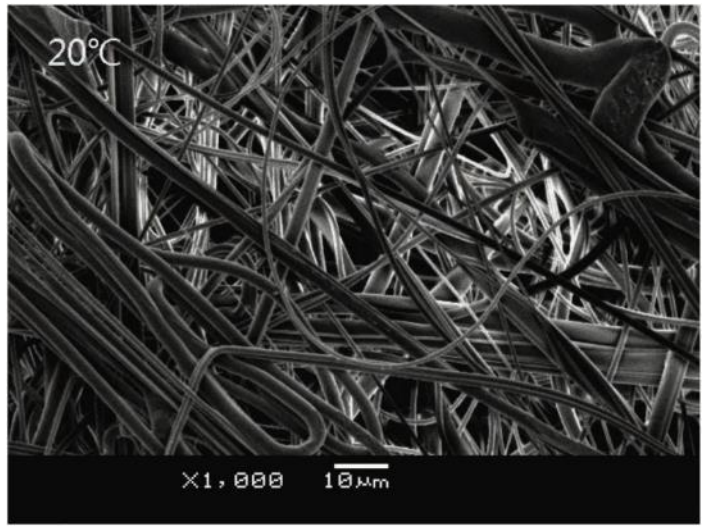
Meltblown polypropylene forms crystal at high temperature

(filtration efficiency is not significant affected)

Table 4. Crystallinity and filtration efficiency of samples

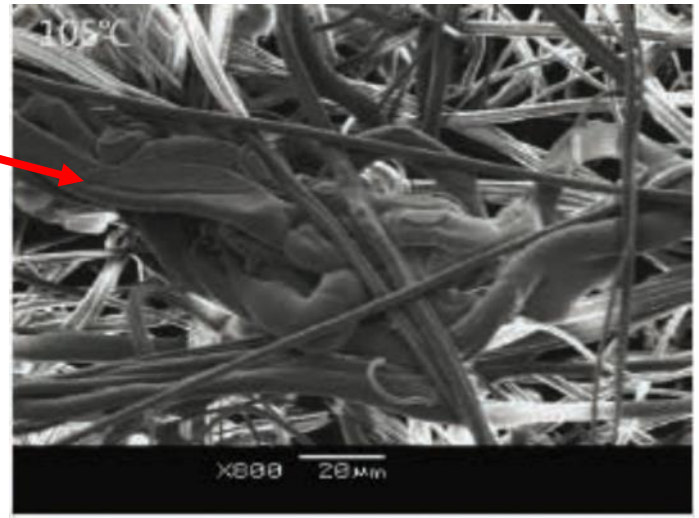
Temperature (°C)	Crystallinity (%)	Efficiency (%)	Temperature (°C)	Crystallinity (%)	Efficiency (%)
20	20.56	96.17	90	43.78	96.71
70	28.67	98.14	95	36.67	96.54
75	41.12	97.43	100	47.23	97.14
80	43.05	98.35	105	48.86	97.34
85	45.09	97.19	110	51.48	92.96

Filter at 20 C°



Filter at 105 C°

Crystal



65-70 C° is preferred temperature for face mask decontamination.

Si Cheng, et al AUTEX Research Journal, DOI 10.2478/aut-2019-0067

Decontamination of used face mask by dry heat in an oven

1) Put the used face mask in a brown bag with your name on it.

2) Bake the bag at 65-70° C (150-158° F) for 30 min.

3) Take out of the oven and cool for 5 min.

We have two tabletop incubators that operate within this range that can be deployed to clinic.

Guideline for reuse of surgical masks

1) **Fluid compromises filtration efficiency, face masks contaminated with fluid should not be reused. Bleach, 70% alcohol, and H2O2 aerosol all have water base.**

2) **UVC does not penetrate far enough to clear virus on the polypropylene filter and has been shown to be less effective in killing Coronavirus. It may also lead to early breakdown of elastic material with repeated treatment cycles.**

3) **Heat sanitizing is a simple, straightforward, and effective strategy for elimination of the virus and is less likely to compromise the integrity of the mask.**

4) **When heat sanitizing, do not place the mask directly on the metal surface, place in brown paper bag with your name on it.**

5) **The 0.3-10 micron pore size of standard surgical face masks is much larger than coronavirus (0.1 µm), and incompletely form-fits the face. Therefore, these masks should not be used when in contact with potential Covid-19-positive patients. N95 should be used in this scenario.**